Comment on nhess-2020-417

The authors present an interesting study focusing on estimating flood damage in a study area in Malawi, Africa. Since this region can be considered data-scarce, a workflow has been established to better map and characterize buildings prone to flooding. The authors use UAV-borne imagery to extract single buildings using an object-based segmentation and classification approach. Based on the resulting semantic objects and their related vulnerability also assessed in the field a more detailed damage assessment is obtained. The results are compared to a more pragmatic approach based on available data.

To begin with, I have a remote sensing background and I'm not too familiar with assessing flood damage in practice. Please consider the comments with this regard. I have to admit that I was on the verge of rejecting the paper, due to methodological weaknesses. Working in a data-poor region can be somewhat challenging, but this argument cannot justify methods and results in conflict with scientific standards. However, I'd like to see if the manuscript can be improved after major revisions to meet the scientific standards of the journal. In the following you will find general and technical comments.

1) General comments

Paper structure

The structure of the paper could be improved by better differentiating between the applied workflows (OBIA vs. pixel-based). Further subsections on the study area and the UAV-results should be added. In the results section a third subsection level should be omitted.

Introduction

- Shorten the introduction to 1 page max
- Summarize the main objectives of the paper and what is the main innovation; ideally as bullet points

Materials and methods (instead of Data and methods)

- Add a subsection describing the study area in detail
    - Location, landscape, characteristics of the river, more details about floods in the past
- Please revise the workflow figure or add a second one to also include the main steps of the flood risk assessment and the main steps of the OBIA, the computation of the inundation maps and the modelling for validating the inundation maps
- Although presented in another paper, some basic information about the acquisition and processing of the UAV imagery is required since it is the primary dataset of the paper
    - Information about the campaign (planned acquisition, type of UAV + model and manufacturer, number of images, number of flight segments, selected overlap,…)
    - What are the regulations in Malawi regarding UAV flights above settlements? In European countries such campaigns would certainly be prohibited. Consider

    - mentioning this issue in the discussion section, this will have implications on the upscaling and transferability of the method
    - Software used (for planning and processing)
    - Results: also 3D point clouds?
    - GCPs used, georeferencing accuracy
    - Overview maps of UAV results
- Field survey: The cited EGU-Abstract does not include information about the recorded building characteristics. If there is no other source yet, it is encouraged to present the data in the results section.
- Assessment of object height (L210ff): This refers to the extraction of a digital terrain model. The state of the art for doing that is to use suitable filters applied to the derived 3D point cloud. This can also be done for point clouds derived from photogrammetric techniques based on UAV imagery, e.g. Zeybek and Sanlioglu 2019 (https://doi.org/10.1016/j.measurement.2018.10.013) and could be done easily e.g. using the CSF-plugin of the CloudCompare software. This would increase the objectivity and reproducibility of the results. Then the height of the objects could be inferred using "zonal statistics" instead of extracting the height at a single point.
- L237 Explain what you mean by "actual value". Does the actual error refer to the spatial correspondence of the reference compared to the classified objects?
- Consider changing the heading of section 2.3 to "Estimation of flooded area and water depth"; Parts of this methods section read like a step-by-step instruction; please revise
- L244f Was the SAR data acquired at the peak flood (the greatest water depth)? If not, how does that affect the estimation of water depth?
- L248f This is a procedure from the SNAP tutorial; add a citation for the tutorial document: http://step.esa.int/docs/tutorials/tutorial_s1floodmapping.pdf
- L270 Does the accuracy of the used data allow for extracting water depths of a few meters? According to the literature the vertical uncertainty of the SRTM data is several meters (e.g. Rodriguez et al. 2006, https://doi.org/10.14358/PERS.72.3.249). Both cited references use a far better baseline DTM (e.g. from LiDAR data) for this purpose.
- L274ff The simulations of the hydraulic model used for the validation of the water depth should be described in more detail

Results

- Try to omit a third subsection level
- Add a subsection describing the resulting UAV data, including a map showing the UAV-based orthophoto and a shaded relief of the resulting digital surface model, including a detailed view
- Field observations: As far as I understand this subsection, the materials of the roof are correlated with the materials of the walls based on the 50 samples from field inspection, right? Please show the respective data, e.g. the percentage of cases for which these assumptions are valid. And is that really valid for the whole area then? From the outline of the study I expected that the main advantage of the UAV-campaign could be to automatically assess the wall materials and add them to the objects as an attribute.
- L357ff Despite the even greater uncertainty of the used data, this is still a quite high deviation. Considering the created damage curves it makes a substantial difference, particularly for the thatch-/traditional type. Add a comment on that.

- Figure 6: The water depth map does not fully confirm the inundation area derived from SAR. There are significant areas with a positive water depth which do not appear in the SAR-based map. Please explain these deviations. This goes along with the previous comment in the M&M section, I guess the vertical accuracy may not allow to extract such shallow differences. For many areas you may end up with apparently negative water depths. Also the relatively coarse spatial resolution at least compared to the UAV-data may affect the actual water depth close to the buildings.
- L379ff This is definitively the case. In a previous study it has been shown that including the normalized digital surface model (NDSM=DSM-DTM) can enhance the OBIA results substantiously from about 70% to 90% (Kamps et al. 2017, https://doi.org/10.3390/rs9080805). I wonder if this could apply in this study as well, particularly considering distinguishing thatched roofs from bare soil. By including the height above ground (NDSM) in the segmentation step (and not in the validation step) this should be possible.
- L407 can you estimate the damage down to the Euro or should it be rather rounded to the next hundred or thousand?
- L419 Is Merz et al. 2004 still state-of-the-art?
- Please explain the results presented in table 6 a bit more.

Discussion

- L444 Limited in terms of spatial coverage? Please explain.
- L449f This is a good point, but it does not only apply to spaceborne SAR platforms. Also other types of satellite imagery (e.g. optical) could be used. Re-phrase the sentence accordingly.
- L451f Do you refer to the materials of the walls and roofs here? Please explain.

Conclusions and outlook

Can you reflect on the ideal scale for establishing damage curves? Is it village per village or up to a whole province? How is such an optimal scale in line with the area which can be efficiently covered by a UAV campaign (order of a few squared km)?

2) Technical comments

Abstract

L17 estimate potential damage

Introduction

L30 The latter is known

L34 Alam et al.

L36 van den Homberg and Susha

L72 “smaller-scale” or “smaller-size”?

M&M

L112 OBIA is already defined earlier

L122 a flood damage assessment

L184f Remove the last sentence

L190 of the neighbourhood distance

L191 minimum segment size to 5 m²

L192f classify the resulting segments into semantic objects according to the desired classes

L205 the segments were classified into semantic objects

L202 greater than 0,5 m

L204 at these points

L219ff These performance metrics are well-known, if you still decide to keep them in the text add respective citations; e.g. Roberts et al. 2019 (https://doi.org/10.3390/rs11161915), Gutierrez et al. 2020 (https://doi.org/10.5194/isprs-annals-V-2-2020-719-2020)

L236 typology -> type?

L241 where

L254 through setting

L256 histogram

L266 remove the S.

L310 that that

Results

L332 susceptible

L356 reference is missing

Discussion

L448 study areas

Conclusions and outlook

L480 structures structures

L500 potentially inundated areas (?)

Tables

Table 2 Bare -> Bare ground (?)

Table3 I'm not familiar with damage estimation for flood risk, but from other types of natural hazards the damage potential is often assessed based on the volume of buildings to account for multi-floor buildings as well. Consider adding a comment on that in the discussion section.

Table 4 Such classification results are typically too low to be accepted, please try to improve the classification as mentioned above.

Table 5 It seems like the other approaches may overestimate the damage compared to the UAV-based results. These results are thus more conservative which could be a better estimation in terms of help for recovery. If the actual damage would be underestimated due to systematic uncertainties handling the UAV-data, this would have consequences for the affected land/home owners. Consider this issue in the discussion section.

Figures

Figure 1 Improve readability, increase font size, mention UAV-data, hydraulic modelling is missing, SRTM-based inundation map is missing, comparison with OSM data is missing

Figure 2 Remove figure title and original caption, highlight the district in the left panel, add area of UAV-campaign

Figure 3 This photo is not part of the cited EGU-Abstract. Please cite the photographer and the date it was taken.

Figure 6 Revise figure caption – the left panel shows the SAR inundation, right? The SRTM data refers to the right panel.

Figure 7 How can the relative error be more than 100%? If the relative error is 100% the objects are not detected at all, right?

References

Please check the title of van den Homberg & Susha 2018: Combining UAV Imagery, Volunteered Geographic Information, and Field Survey Data to Improve Characterization of Rural Water Points in Malawi